JACKFISH LAKE

Alberta
ENVIRONMENT

89-05684/

Lakes attract people. And people want to know why "their" lake is the way it is — why is it so green in July? Is the water quality really deteriorating? How do our activities affect the lake?

This brochure, one of a series on Alberta's lakes, attempts to answer these questions by presenting findings of water quality studies conducted by the Environmental Assessment Division of Alberta Environment.

As you read through the brochure, you may find that you have questions about the concepts and illustrations. At the end is a section called **Explanation of Lake Characteristics**. Refer to this for further interpretation.

Brochures are available for the following lakes:

Sandy Lake	Pine Lake	Lac la Biche
Lac la Nonne	Garner Lake	Nakamun Lake
Wizard Lake	Skeleton Lake	Lac Ste. Anne
Pigeon Lake	Jackfish Lake	Baptiste Lake

April 1989

Jackfish Lake is an attractive, heavily used recreational lake located about 50 km west of Edmonton. To reach the lake, take Highway 16 west from Edmonton to Secondary Road 770. Drive south for about 10 km and turn west to the east side of the lake.

Almost all of the shoreline around Jackfish Lake is privately owned. Eight subdivisions and leased properties have been developed near the lake and on three islands; these properties include 250 cottages and trailers. On the east shore, the county-owned Jackfish Lake Recreation Area provides day-use facilities including picnic sites, a boat launch and toilets.

Jackfish Lake is often very busy on summer weekends. Powerboating and waterskiing are favourite activities. Many people swim in the lake, although there are no developed beaches. The diverse recreational activities at Jackfish Lake sometimes conflict with each other.

Fishing

Jackfish Lake has a moderately active sport fishery, particularly for northern pike (jackfish) and yellow perch. The lake also supports small numbers of walleye, as well as brook stickleback, spottail shiners and Iowa darters. Northern pike are caught more frequently than other types of fish. The extensive beds of aquatic plants along the shore provide excellent pike spawning and rearing habitat. Yellow perch in Jackfish Lake tend to be stunted in size, but fairly abundant[1].

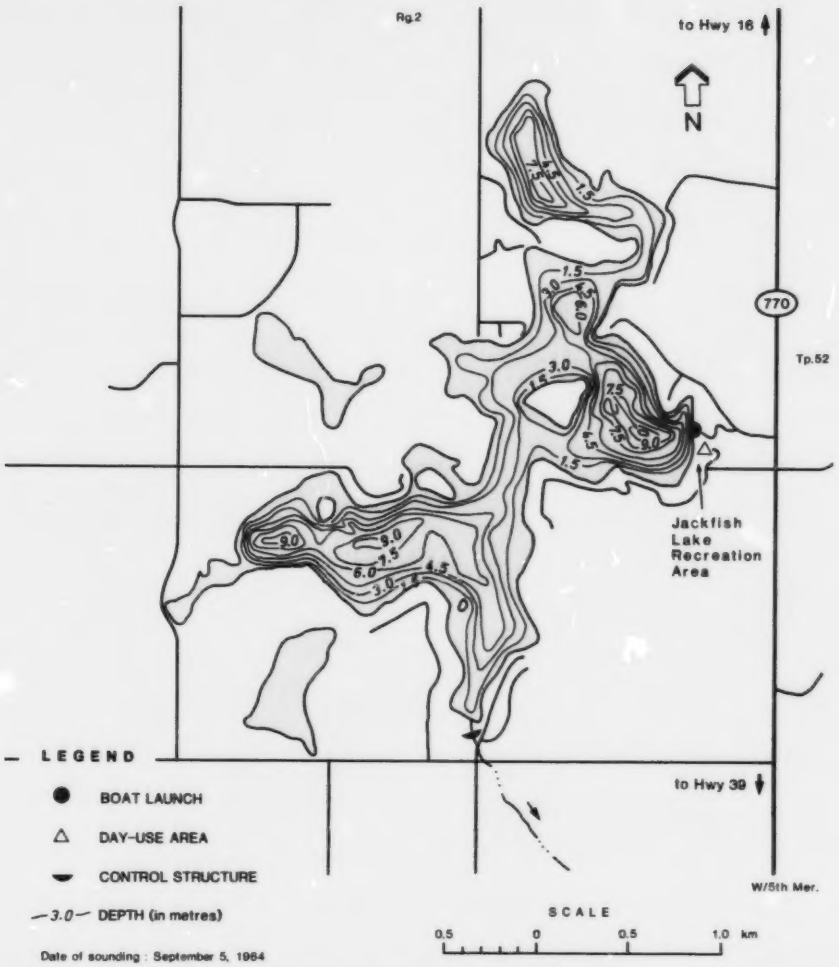
Physical Characteristics

Jackfish Lake is small, with an irregular shape and many bays. The lake consists of three distinct basins, and there are five islands (see the Depth Contour map). The treed shoreline, bays and islands provide shelter from strong winds. The maximum depth of this shallow lake is about 9 metres.

The basin of Jackfish Lake is situated in a glacial depression. There are only intermittent creeks flowing into the lake, and water drains in from diffuse runoff, groundwater and precipitation. Before 1982, the outlet channel on the south end of the lake was overgrown and usually dry. Between 1970 and 1982 the water level of the lake rose by 1.4 metres (see the Historial Water Level graph). In 1982 the County of Parkland cleared the

[1] R.L. & L. Environmental Services Ltd. 1987. County of Parkland fisheries inventory: Jackfish Lake. Prep. for Alta. Forestry, Lands and Wildlife, Fish and Wildlife Division, Edmonton.

Depth Contours of Jackfish Lake



PHYSICAL AND HYDROLOGICAL CHARACTERISTICS[a]

LAKE AREA[b]	km^2	2.39
DRAINAGE AREA (excluding lake)	km^2	12.6
DRAINAGE AREA/ LAKE AREA		5.3
VOLUME	m^3	8.18 x 10^6
MAXIMUM DEPTH	m	9
MEAN DEPTH	m	3.4
SHORELINE LENGTH	km	18.1
TOTAL INFLOW[c]	m^3/yr	1.59 x 10^6
EVAPORATION	m^3/yr	1.59 x 10^6
RESIDENCE TIME[c]	years	>100

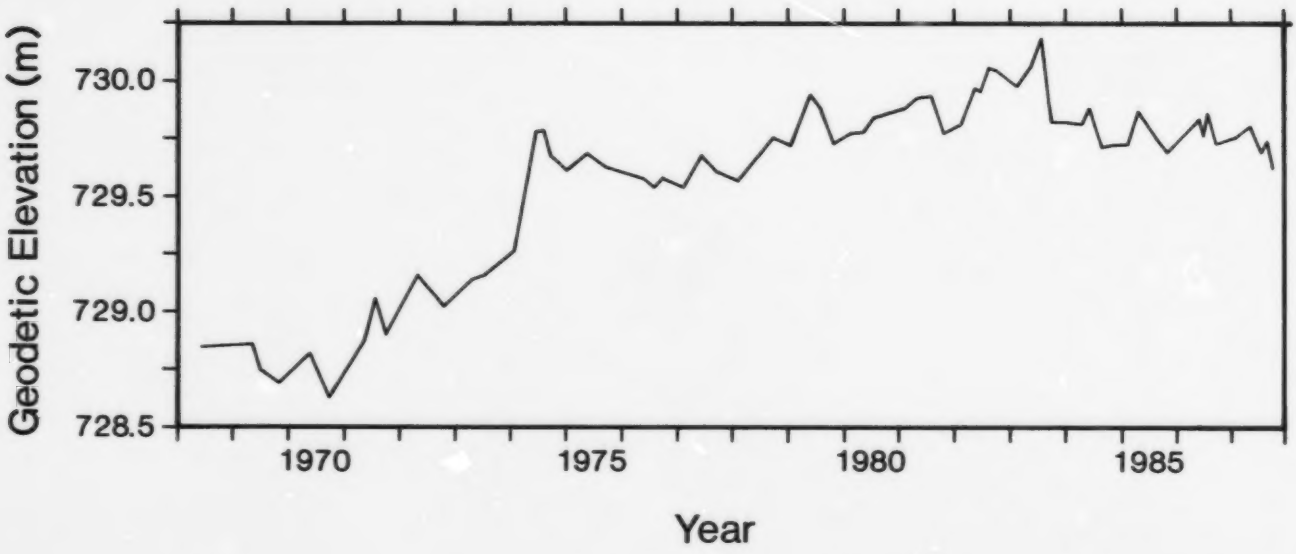
[a] Technical Services Division, Alberta Environment

[b] From hydrographic survey map, sounded in 1964

[c] Excludes groundwater

natural outflow channel and constructed a culvert and weir to regulate the lake level. Water will drain out of the lake when the elevation surpasses 729.72 m. Since 1983, however, the level has declined and water flows only intermittently through the outlet.

Historical Water Level of Jackfish Lake



Nutrient Sources

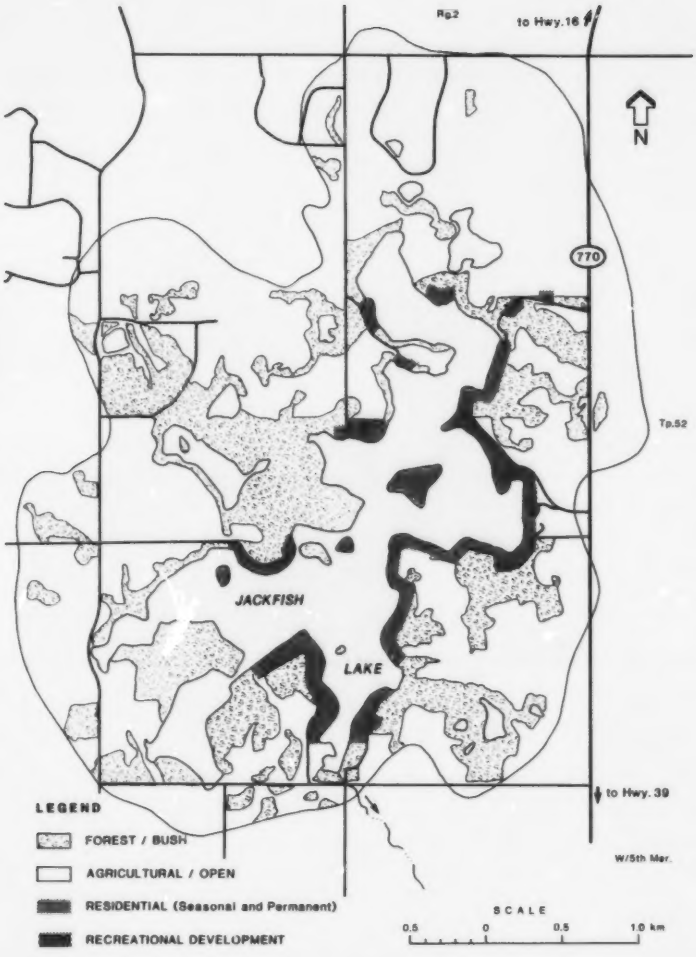
The growth of plants, including algae, in a lake depends upon the amount of nutrients available to them. Phosphorus is the nutrient that most directly determines whether a lake is green and weedy or clear and clean. The Theoretical Phosphorus Supply table shows the estimated amounts of phosphorus that enter the lake from different external sources. Much of the phosphorus entering Jackfish Lake each year originates from runoff from the watershed, which is only about five times the size of the lake. As shown on the Watershed Map, 60% of the watershed has been cleared for agriculture; this land accounts for almost half of the estimated phosphorus supply. Septic systems in lakeshore developments probably contribute a relatively small amount of phosphorus to Jackfish Lake, although it has never been measured. The quantity reported in the table is estimated from studies on other Alberta lakes.

Unquantified sources of phosphorus include groundwater inflow (springs in the lake), and the lake bottom mud. The mud or sediment at the bottom of the lake may contain very large amounts of this nutrient. Under certain conditions, particularly in July and August, phosphorus moves from the sediment to the overlying water. Blue-green algal blooms are often the result of this "fertilization".

Although the total amount of phosphorus entering Jackfish Lake each year is not very large, the lake itself is small. The annual areal loading figure of 0.14 g of phosphorus per square metre of lake area is typical of mildly eutrophic (fertile) lakes.

SEE "EXPLANATION OF LAKE CHARACTERISTICS" AT END OF BROCHURE FOR CLARIFICATION OF THESE TERMS AND CONCEPTS.

Watershed of Jackfish Lake



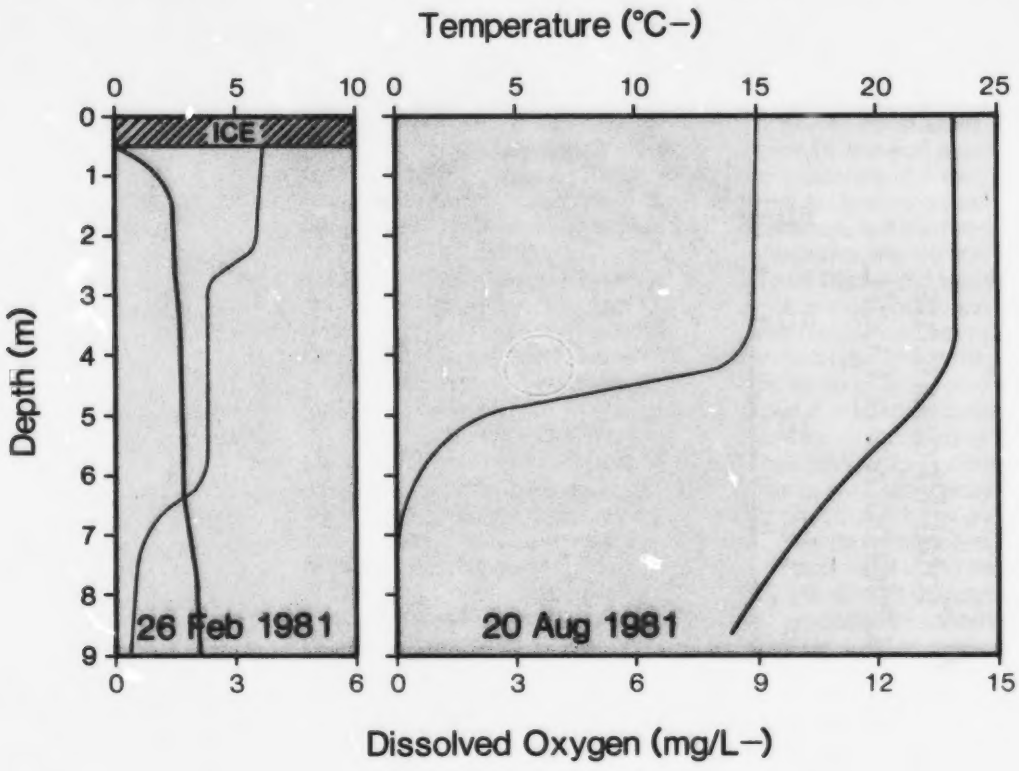
THEORETICAL EXTERNAL PHOSPHORUS SUPPLY	kg/year	Percentage
SURFACE RUNOFF:		
Forested/Bush	37	11
Cleared/Agricultural	157	47
Urban/Cottage	58	17
PRECIPITATION, DUSTFALL	55	17
SEWAGE FROM COTTAGES AND CAMPS	25	8
TOTAL	332	100
AREA LOADING, g/m² OF LAKE SURFACE	0.14	

Temperature and Dissolved Oxygen

The level of dissolved oxygen in Jackfish Lake may become extremely low during winter. This is shown on the Temperature and Dissolved Oxygen graph for 26 February 1981. Dissolved oxygen was less than about 4 mg/L in the area of the lake that was sampled.

In summer, as shown for 20 August 1981, the lake was "thermally stratified"; that is, the top four metres of water were warmer than water near the bottom of the lake. Under these conditions the water in the deeper regions resists mixing on windy days. Oxygen from the air cannot replenish this bottom water, and natural decay and

Temperature (°C) and Dissolved Oxygen (mg/L) in Jackfish Lake



respiration reduce oxygen levels. The graph shows that no oxygen remained in the water below depths of seven metres. From April to September in 1981 there was no oxygen in the bottom metre of Jackfish Lake. In spite of periodic low levels of dissolved oxygen, fish kills in winter and summer do not seem to be a problem in this lake.

Chemistry

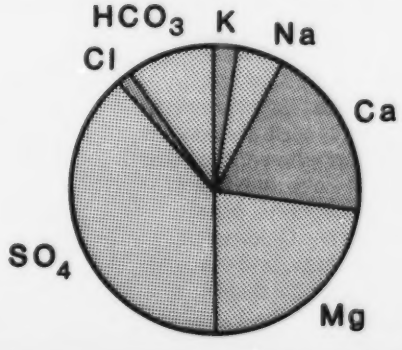
The water in Jackfish Lake is fresh, even though the salinity (saltiness) is slightly higher than in most freshwater lakes. The pattern of ions, as shown in the Ionic Diagram, is interesting because the major ions are sulfate (SO_4), magnesium (Mg) and calcium (Ca). In many Alberta lakes the dominant ion is bicarbonate (HCO_3). Groundwater in the Jackfish Lake area has high levels of sulfate, which might account for the high sulfate in the lake.[2] The water has less alkalinity than in many Alberta lakes.

CHEMISTRY Ice-Free Season Averages - 1980-1981

CONDUCTIVITY	µS/cm	918
pH (RANGE)		7.4-9.6
ALKALINITY	mg/L*	98
TOTAL DISSOLVED SOLIDS	mg/L	569

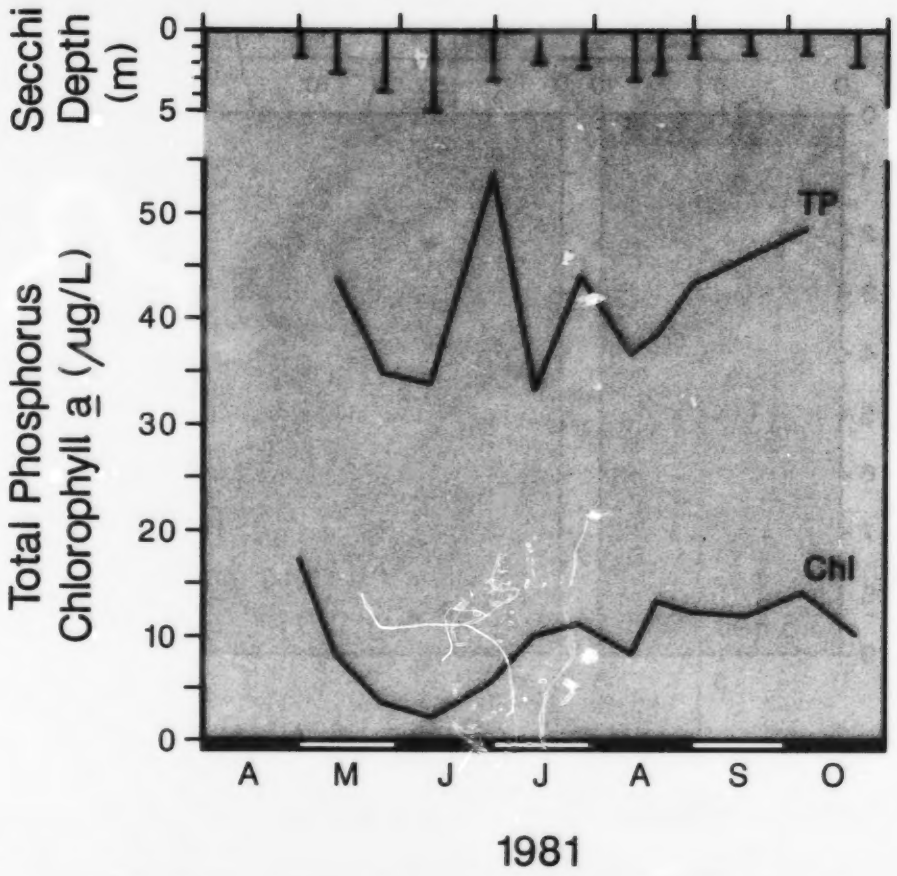
* milligrams per litre = one thousandth of a gram in a litre = parts per million

IONIC DIAGRAM Relative proportions of ions in Jackfish Lake 1980-1981



[2] Rippon, R.E. 1981. Groundwater availability — Jackfish-Mayatan lakes area, County of Parkland. Dept. of the Environment, Environmental Protection Services, Earth Sciences Division.

Trophic Status of Jackfish Lake



Algae and Trophic Status

The fairly high concentrations of phosphorus and chlorophyll (a measure of algae) in Jackfish Lake suggest that the lake is mildly eutrophic. Blue-green algae sometimes form nuisance blooms or scums. Depending on the type of algae, they may look like short grass clippings or tiny, grey-green globules. These algae are common in many lakes in the area, and are typical of eutrophic or fertile water bodies.

The Trophic Status graph shows how concentrations of phosphorus and chlorophyll changed over the period that Jackfish Lake was free of ice in 1981. The phosphorus level fluctuated considerably. Chlorophyll was highest in early May, and the clarity of the water (Secchi depth) was lowest at this time.

The water quality of Jackfish Lake is quite acceptable for recreational pursuits, even though the water is green at times during the summer. It is likely that the lake's fertile condition results in part from the recycling of phosphorus from the bottom sediments.

TROPHIC CHARACTERISTICS Average Values May - October

		1980	1981
PHOSPHORUS	µg/L*	**	39
NITROGEN	µg/L	1259	1174
CHLOROPHYLL	µg/L	12.6	9.2
SECCHI TRANSPARENCY	m	3.0	2.4

* Micrograms per litre = one millionth of a gram in a litre = parts per billion

** Data not available.

Explanation of Lake Characteristics

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Drainage Area or the watershed of a lake is the land surface from which a lake receives its water. As rain water or snowmelt gathers in streams, it picks up soil particles, nutrients and other materials and carries them to the lake.

A study of more than 30 Alberta lakes shows that when drainage areas are large compared to lake areas, (i.e. when the **Drainage Area/Lake Area** ratio is large), lakes have more algae (are more eutrophic) (see TROPHIC CHARACTERISTICS).

Mean Depth is the volume of the lake divided by the surface area. Shallow lakes are often more eutrophic than deeper lakes of a similar surface area.

Inflow is the total volume of water entering the lake in a year. It is related to **Residence Time**, which is the time it would take the inflow to completely fill the empty lake basin.

The **Geodetic Elevation** on the water level graph indicates the level or elevation of the lake above mean sea level.

TEMPERATURE

Alberta lakes show two basic annual patterns of temperature distribution through the water.

Deep lakes, or those protected from strong winds, form layers with the coldest water near the bottom in summer. Because this colder water is denser, it resists mixing into the warmer, lighter, upper layer.

For much of the summer, the bottom portion of water is isolated from the top portion. In spring and fall, these lakes usually mix from top to bottom by wind action as the water becomes uniform in temperature and density. In winter, under ice, the warmest water (about 4ºC) is on the bottom, because water is most dense at this temperature.

Shallow lakes mix throughout the summer or layer only temporarily. In winter, the temperature pattern of these lakes is similar to that of deep lakes.

DISSOLVED OXYGEN

Oxygen is essential to the life in lakes. Oxygen from the air dissolves readily in water, especially on windy days when waves break up the lake surface. The photosynthesis of small aquatic plants also supplies a large amount of oxygen to the lake water.

Oxygen is consumed by respiration of animals and plants, and by the decomposition of dead organisms by bacteria. A great deal can be learned about the "health" of a lake by studying its patterns and quantity of oxygen.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more eutrophic, and increasing quantities of plants and animals respire and decay, the balance shifts towards consumption — especially near the lake bottom where dead organisms accumulate.

In deep productive lakes (see TEMPERATURE), the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 3 mg/L). Fish kills occur when decomposing or respiring algal populations use up the oxygen. In summer, this usually happens when an algal bloom "collapses" or dies suddenly.

SALINITY AND TOTAL DISSOLVED SOLIDS

Lake water contains a multitude of dissolved substances. These can be seen by allowing a dish of lake water to evaporate. If the water is filtered to remove living organisms and other particles, and then allowed to evaporate, the residue is called **Total Dissolved Solids**.

The ions* that make up most of this residue can be measured individually. The **Ionic Diagram** presents all of the major ions in a lake in proportion to each other. The salinity or saltiness of the water is indicated by its **conductivity**. Water that is low in conductivity (salinity) conducts electricity poorly.

Salinity is controlled by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. Lakes of high salinity, such as many of those found in southeastern Alberta, have fewer species of plants and animals than freshwater lakes; many are too saline to support fish.

* Ions: Chemical form in water of constituents such as sodium and carbonate.

pH AND ALKALINITY

The **pH** of lake water refers to its concentration of hydrogen ions on a scale that runs from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral - neither acidic nor alkaline.

Most Alberta lakes fall between pH 6 to 9, with the majority on the alkaline side. **Alkalinity** refers to the capacity of water to neutralize an acid, and is a measure of the alkaline materials present in the water.

Alberta lakes that were formed in sedimentary bedrock have a large capacity to neutralize acids entering them, such as from acid rain.

THEORETICAL PHOSPHORUS SUPPLY

Lake scientists know that for most lakes, the amount of algae in the water is related directly to the amount of phosphorus. This is because phosphorus is usually in shortest supply relative to all the nutrients that lake plants need. When it runs out, the algal population can no longer increase. A larger phosphorus supply usually results in more algae.

Based on studies from all over North America, the quantity of phosphorus contributed by a hectare of forest during runoff is remarkably similar no matter where the lake is located. Similarly, agricultural or cleared land overlying sedimentary bedrock contributes fairly similar quantities of phosphorus per hectare in most lake watersheds. This was confirmed for Alberta by measuring quantities of phosphorus supplied by various land uses in several lake watersheds.

In all studies, the phosphorus supply from cleared or agricultural lake was greater than that from forest, averaging 2 to 5 times more.

The **Theoretical Phosphorus Supply** is estimated by multiplying phosphorus supply factors for each type of land use by the area of that land use, and then summing the products.

Similar factors are used for the supply from precipitation. The supply from sewage is estimated based on a percentage of the total amount that could be generated by cottages and camps on the particular lake.

It might be expected that a large phosphorus supply would produce a eutrophic lake. But the size of the lake is also important. If the total phosphorus supply is divided by the surface area of the lake, the resulting **Areal Loading** figure can be compared with other lakes, and can be used as an indication of trophic status.

TROPHIC CHARACTERISTICS

The word "trophic" literally means nourishment.

Mountain lakes usually are "poorly nourished" or **oligotrophic**. Levels of nutrients such as phosphorus and nitrogen are low, plant life is sparse, and the water is clear. Fish production is low.

On the other end of the scale are well-nourished or fertile lakes called **eutrophic**. In these lakes, aquatic plants, including tiny suspended algae, flourish because the water contains abundant nutrients.

Mesotrophic lakes, those intermediate in fertility, often combine the best features of the other two types.

In some lakes, the nutrient supply is so high that plant growth inhibits certain recreational uses of the lake. Lake users may consider such a lake to have poor water quality. One of the purposes in studying lakes is to determine whether fertility is increasing.

There are several ways to measure a lake's fertility or **Trophic Status**.

Phosphorus and **nitrogen** can be measured directly. Phosphorus in lakes of the Boreal Forest/Parkland areas of Alberta ranges between 10 and 200 micrograms per litre* (μg/L) (oligotrophic to highly eutrophic), and nitrogen ranges between 500 and 3500 μg/L.

Transparency of the water declines as a lake becomes more fertile. It is measured with a black and white plate called a **Secchi Disk**, which is lowered through the water on a line marked at metre intervals. The depth at which it can no longer be seen is the **Secchi Transparency**.

The quantity of algae in the water can be determined by measuring its content of **Chlorophyll a**, the green photosynthetic pigment.

* equivalent to parts per billion

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